This book addresses people of widely different backgrounds who want to get insight in the power of music, that is, the effect of music on our emotive, cognitive, motor, and social abilities. Where does this power come from? What mechanisms support this power? How do we control this power? Can technology enhance this power?

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With contributions of seven experts in different fields such as musicology, ergonomics, acoustics, physics, and movement science, this book reveals information that is less publicly known. The authors discuss topics as varied as basic concepts of musical embodiment, music performance, mediation technology as an extension of the body, social interaction in music, music education, health, rehabilitation and lifestyle, and fundamentals of music and movement.

This book aims at making a powerful statement about music research, by making its methods and approaches understandable. The examples of new applications will change the way you think about music interaction.

Since 1998, Micheline Lesaffre has been working as a researcher in Systematic Musicology at IPEM at Ghent University. She holds a PhD in Musicology about user-centered approaches to Music Information Retrieval and issues of the perception of high-level semantics of music. Her main concentration over the last period has been on user-oriented analysis, the usability of music tools, user experiences, and social-economic issues related to stakeholders in the cultural and creative sector. Her research results are published in major international peer-reviewed journals.

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Understanding Social Interaction in Music

Christiaan Müller

Introduction

Music is an inherently social phenomenon. People make music together, and often music is played for an audience. Music harnesses many aspects of human social interaction. Social interaction can imply many different forms of human contact, but it always involves people acknowledging each other’s presence, somehow. We could define social interaction as the process of people responding to one another, either consciously or unconsciously, either voluntarily or involuntarily. For example, people tend to adapt their behaviour to one another without realizing it. Issartel, Marin and Cadopi (2007), Oullier, De Guzman, Jantzen, Lagarde and Kelso (2008) or Richardson, Marsh, Isenhower, Goodman and Schmidt (2007), discussed, for example, how people spontaneously synchronise their movements when they can observe each other’s movements. People, of course, respond to one another in music too, whether it is at several levels, whether it is voluntary or not, and whether it is conscious or not. People synchronise their movements to music almost automatically. Virtually everybody will recognize the involuntary tapping of the foot to the beat of the music that is playing. Music has a strong effect on people’s individual behaviour, as well as on their interaction with each other. De Bruyn, Leman, Demey, Desmet and Moelants (2009), for example, empirically quantified the impact of a social factor on movements made by groups of adolescents while dancing to music. It was shown that the social context stimulated participants to synchronise better with and move more intensely to the music, and it also increased the synchronisation of the movements between the individuals. Just as in the studies mentioned above on interpersonal synchronisation, being able to observe others moving, in this case when dancing to music, changed the movements of others. It would seem that the presence of others causes people to respond differently to music than when they are alone.
Music does not just change the way we move to music, alone or in company. It has been suggested that music plays a crucial part in social interaction because it can be seen as a form of communication which hardly suffers from conflict, and which promotes a sense of shared goals among people (Cross, 2006). A sense of shared goals is essential to promote cooperation between people: it explains why music might be embedded deeply in our social behaviour, and it makes music a very promising source of information on human social interaction.

**Key Concepts**

Apart from embodied music cognition (Leman, Chapter 2) key concepts currently in music and social interaction studies are entrainment, and joint action. These three concepts are closely linked through social interaction and as such have relatively recently come under scrutiny by researchers stemming from various backgrounds. In what follows, we will describe some of the key concepts in social interaction research in music.

**Entrainment**

Generally, entrainment is defined as the process of two oscillating systems becoming synchronised due to a weak coupling between the systems (Figure 5.1). A weak coupling means that the systems can exert an influence on each other to a certain extent, and thus alter each other’s oscillating behaviour. This can also be thought of as systems that resonate with one another. In fact, a theory that hypothesises a dampened resonating oscillator in the human perceptual motor system has shown to be a good tool for explaining a number of musical synchronisation phenomena in people (van Noorden & Moelants, 1999). Synchronisation can manifest itself in several strengths: as completely phase locked, just equality in tempo or even merely in relative coordination. The third case means that the systems are only in synchrony for a significant period of the time.

In the context of social interaction in music, entrainment is observed when a person synchronises his or her body movements to an external musical stimulus (for example made by another person or by a computer) or to the movements of other people. The coupling of systems, in the case of people dancing together, can consist of the people being able to see each other’s movements. In this case, their motor systems are coupled via visual information. Of course, they also hear the music that is playing, which is also an oscillating system that the people can become entrained to. Note that in the latter case, the music normally does not adapt to the movements of the people. Entrainment and synchronisation are thus not necessarily processes that involve mutual adaptation.

Mutual adaptation, furthermore, does not imply that the coupling strength between two oscillating systems is symmetrical. That is, the two systems do not necessarily exert the same amount of influence on each other. In the simplified case illustrated
in Figure 5.1, the end state of the two oscillating systems is one in which both have a frequency of 3 Hz, thus implying that the system that started with a frequency of 3 Hz is not susceptible to the influence of the other system. In living oscillating systems, the relative influences on one another or the coupling strength varies greatly.

![Figure 5.1](image.png)

**Figure 5.1** Representation of the entrainment process: two weakly coupled oscillators approach the same frequency of 3 Herz.

**Entrainment Strength**

One can imagine that in the case of two people synchronising their movements, or a group of musicians synchronising their playing, certain individuals are more rigid in their playing. They do not easily adapt to others, but force others to adapt mostly to them, just as when a person synchronises to an external automated signal, like a metronome or the music played by a DJ. It has been shown that the tendency to adapt correlates to certain personal traits, essentially meaning that there are always leaders and followers in a synchronising group of people. In a study by Schmidt, Christianson, Carello and Baron (1994), it was shown that two people who were asked to synchronise the swinging motion of their wrist pendulums can perform this task in the most stable manner when they are pairs of people of whom one was of high social competence and one of low social competence. This suggests that the tendency to synchronise and entrain to others’ movements in musical contexts can serve as a useful model to study concepts like empathy and social cognition. Castellano, Villalba and Camurri (2007), for instance, have shown that computer modelling of movements and gestures...
to infer psychological states of people is a fruitful direction of research. Understanding the psychological state of another person from their movements would provide that basis for movement based action understanding.

**Joint Action**

Joint action, coordinated action between people, is the generic term that describes actions that several people perform together in time. Note that these do not have to be the exact same actions; they can also be complimentary actions. Joint action is characterised by synchronisation, entrainment, minimised effort through collaboration and people’s shared goals. Making music together, or listening and dancing to music together is also a type of joint action, with a shared goal, and requires people to keep together in time. Keeping together in time forges a bond between the participating individuals: it is said to stimulate a sense of connectedness and increased rapport (e.g. Chartrand & Jefferis, 2003), and muscular bonding (McNeill, 1995). Muscular bonding is described as a process whereby prolonged rhythmic muscular movement performed by a group of people arouses a strong feeling of social cohesion. To a group of people in any society, this feeling of belonging to a group undoubtedly has advantages in terms of collaboration. Furthermore, it has been suggested that to an observer, a tightly synchronised group of people, for example playing music or dancing together, signals a strong coalition among them (Hagen & Bryant, 2003). This could explain how music has evolved in human societies. Van Noorden discusses this subject in more detail in Chapter 8.

Until recently, research in social interaction and joint action has focused on interpersonal synchrony, without specifically focussing on social interaction (e.g. Richardson et al., 2007). It was often concerned with modelling the interacting systems. For instance, the Haken-Kelso-Bunz equation (Haken, Kelso, & Bunz, 1985) can be used to predict the behaviour of weakly coupled oscillating systems, including two individuals that can see each other moving, for example.

Looking at joint action from the point of view of embodied cognition, whereby the action perception cycle in behaviour is investigated and focussing on an informational link between individuals, incorporating a social perspective is relatively new (e.g. Macrae, Duffy, Miles, & Lawrence, 2008; Woolhouse & Tidhar, 2010). This is especially so when the focus is on the informational link, that is: how the sensory information that an individual can gather from the environment, including the behaviour and movements of other individuals, impacts their behaviour (Marsh, Richardson, & Schmidt, 2009). Recent developments in systematic musicology have embraced work on social interaction and interpersonal synchrony. By charting the characteristics of social interaction in music, powerful predictions can be made about the musical circumstances that facilitate joint action, and can thus induce a feeling of connectedness among people in either performing or listening situations (e.g. Miles, Lumsden, Richardson, & Macrae, 2011). By developing a model of joint action in music, optimal circumstances
Studying Social Interaction in Music

From a research perspective, it is useful to distinguish two ways to approach the concept of social interaction when it comes to its relation to music. On the one hand, music can be the platform through which people interact; in this case the music is the result of the interactions. Interaction as such can be studied at the level of the music, by analysing the phrasing or the tempo for example, or at the level of the audio features of the music, or at the level of the movements that the musicians make when they play. On the other hand, music as a stimulus can be the driving force behind social interaction. In this case, the behaviour of the individuals can be studied through their interactions, for example by studying their movements and focusing on the relations between the movements of individuals in a group. This can give us a measure of entrainment between individuals.

Motion Capture

Studies of social interaction in music have focussed primarily on recording movements of groups of people who are listening to or playing music. The main reason for recording these movements is to be able to analyse their periodicity in relation to the periodicity of the movements of other people and/or the periodicity of the sounds that are made or used as a stimulus. The analysis of periodicities in movement can be used to determine the level of synchrony, and thus the level of entrainment between people. In a pilot experiment on entrainment, two groups of about 17 people were each instructed to march together in time, synchronising a drum rhythm to the groups’ steps. The starting tempos of the two groups were slightly different. The two groups were positioned at opposite starting points so that they would pass each other after 50 meters. They were instructed to maintain their respective tempos. The experimenters recorded the drum rhythms and the walking movements of the groups. By analysing the periodicities of the sounds and movements, the experimenters were able to show that the groups were unable to maintain their respective tempos. Instead, their walking tempos and drum playing became entrained; during the exposure, the groups’ tempos became synchronised.

Because movement serves as the primary measure of social interaction in music, many different technologies for measuring movement are being used. Currently, most researchers use a type of 3D infrared camera system that is capable of high temporal and spatial resolution in recording small reflecting ’markers’ that can be attached to various part of the body. This involves the use of several other motion-sensing devices,
both video-based and Micro-Electrical-Mechanical-Systems-based (for example Wii), as well as various types of controllers such as joysticks and graphic tablets. Lastly, an important methodological tool that is used is audio recording. Many studies involve participants producing sound. In this case, high quality audio recordings are made to make detailed analysis of periodicity in audio signals possible. Demey discusses the technology in more detail in Chapter 4.

**Questionnaires**

In order to make an informed connection possible between objective recorded data and the subjective experiences of participants, experiments also need to include a questionnaire. Depending on the experiment, questionnaires can be more or less extensive. Often it is important to know a participant’s background in terms of musical training, age, handedness and dance experience for example in order to rule out factors that are not part of the experiment, but that might affect the outcome. The questions are, therefore, designed as such that the answers can exclude the influence of certain factors, such as individual differences between participants, on the experimental outcomes.

**Types of Interaction**

In any given musical situation, different types of interaction between people can be distinguished (Figure 5.2). Interaction between members of an audience, for example, might involve changes in their dancing tempos, while musicians on stage at a concert interact by exchanging eye contact to synchronise their playing in key passages in a musical piece, for example (e.g. Camurri & Varni, 2009).

**Context**

The context of the situation in which the music takes place will determine which types of interaction can be found in it. In a concert situation (Figure 5.2 Top), musicians interact with one another during their performance (1) performers interact with their audience (2) and people in an audience will interact with each other when they are listening to music together (3). These types of interactions can occur in all possible combinations, of course, and they need not all occur at the same time. Social interaction, as in a performer who is communicating with an audience (2) through several parallel channels (for example sound, body movements, facial expressions) can inform us about the fundamentals of human interaction, and how for example body language and semantic content relate to sounding communication in conveying one’s emotions and intentions. Demoucron discusses this in more detail in Chapter 3.
Figure 5.2  Top: Types of social interaction in a concert situation. Musicians interact with one another (1) and with the audience (2); the audience interact with each other (3). Bottom: Types of social interaction in a home listening or club situation. Listeners respond to the music (2) and interact with each other (3).
In other situations, for instance when listening to music at home or when a DJ plays records at a club (Figure 5.2 Bottom), the listener may respond (for example by moving to it) to music (2) and therefore respond to the musicians and composers that performed the music. Although in this situation listeners could also interact with each other (3), this does not involve interacting with the musician. The behaviour of listeners to music can nevertheless be studied with the same methods as those used to study the types of interaction described above. Moreover, an individual listener’s behaviour can be a useful reference for comparison to group behaviour.

Researchers generally strive to design experiments in the most ecological setting possible. This means that the experimental setting always mimics a naturally occurring situation as accurately as possible, for example by creating a club-like environment in the laboratory, or by measuring in a real performance situation using unobtrusive sensor technologies. Two examples of this kind of studies on various types of interaction will be described in the next section.

Moelants, Demey, Grachten, Wu and Leman (2012) is an example of an ecologically valid experimental setting that investigates audience-performer interaction. In this study, an investigation was carried out into the effect of an audience on the performers and the performance. Two performances, one rehearsal and one concert performance were recorded using motion sensors, video and audio recordings. Analysis of the recorded data showed that movements of the performers were more intense during a concert performance situation, and that tempos of the pieces were more divergent during the concert performance. Relatively fast pieces were performed faster in a concert setting than in a rehearsal setting, and relatively slower pieces were performed slower in a concert setting than in a rehearsal setting. This study isolates and describes in detail the components of a performance that are specific to interaction with an audience, besides other possible interactions, like those between the performers, for example.

Van Dyck, Moelants, Demey, Coussement, Deweppe and Leman (in press) provides an example of a study that investigates listeners’ responses to a musical stimulus in a social and ecologically valid context. In this study, the effect of the dynamics of the bass drum on a dancing audience was explored and as such focuses on within-audience interaction. A club-like environment was constructed and 100 adolescent and adult subjects (50 male and 50 female) were asked to dance in groups of five to a 10 minute and 30 second musical mix consisting of six songs, three bass drum solo parts and some transitional material. The results showed that the increasingly important role of the bass drum in contemporary dance music is not just a stylistic element, but indeed has a positive effect on the amount of movement made by the dancers.

In line with the current notion that social interaction is based on an informational link between individuals, the experimental methodologies in social interaction are often designed to intervene in the so-called action-perception cycle in some way. A situation, in which normal musical social interaction can be expected, is used as the starting point for the measurement situation, and in several separate conditions
there is a systematically imposed deviation of one aspect of the situation in this situation. A comparison is then made between the ‘normal’ situation and the one in which action-perception interventions were made. Analysing differences in synchronisation parameters between participants, for example, can help us understand the effects of the intervention. In the example of the bass drum study described above, the systematically varying dynamics of the bass drum in the music were used as an intervention.

**Ongoing Social Interaction Studies**

As social interaction in musical behaviour is becoming an important research field, several ongoing studies fit into this category. Two examples are described below.

**Silent Disco**

In an ongoing project on within-audience interaction called *Silent Disco*, the relative contributions of different sensory cues to movement synchronisation in a social context are being investigated. In the experiment, a group of ten people are given wireless headphones on which music is played. The people are divided into two groups of five. The groups are given different items of clothing to signify their group identity. Both groups are instructed to dance together to the music they hear. The movements of the people are captured and analysed in terms of dancing tempo (Figure 5.3).

**Figure 5.3** The silent disco experiment. Two groups of 5 persons wearing headphones with infrared markers are instructed to dance together. One person hears the same music with manipulated tempo (red headphone).
Per three-minute time slot, the headphones of one person in one of the groups played music of which the tempo is manipulated. It gradually changes tempo over the course of several minutes. At some point during the course of the increasing change in the music’s tempo, that person will no longer be able to dance synchronously to both the music and the other people dancing because the other people will still be dancing to the original tempo. This odd person out will experience a conflict and will have to choose between dancing according to visual cues and auditory cues for dancing tempo. Thus by analysing the tempo and phase in which the people are dancing relative to that of the music that they hear, and relative to the tempo and phase of the other dancers, we are able to assess the relative contributions of visually available social dancing tempo cues and auditory tempo cues to entrainment. This will provide important insights into the multimodal feedback used by people to synchronise their movements in a natural situation.

Dansync

Dansync is an example of a social music game developed at IPEM. It is a high-level multimedia game in which people are equipped with markers for infrared 3D-camera tracking and an iPod Touch that provides performance feedback (Figure 5.4). The game comprises several levels at which players dance alone or together in order to score points. One of the main goals is to promote social interaction in public spaces.

![Figure 5.4](image)

**Figure 5.4** The Dansync game. The dancers (2 teams) are equipped with iPod Touch and a helmet with infrared markers. Instructions and feedback are projected on the iPod and on the screen.

As a research project, it will yield insight into the effects of social context on interpersonal synchronisation in dance. So far, it has been shown that not only the social
context stimulates participants to synchronise better with and move more intensely to the music, it also increases the synchronisation of the movements between the individuals.

Applications

In developing applications for research in social interaction and music, the goal of the research plays an important role in determining whether it should be carried out in a lab or in a natural setting, for example, and who should be chosen as test subjects. Examples of current goals include: the promotion and facilitation of social bonding and interaction between people in public spaces, the facilitation of music learning in an interactive social context (learning music together) and the embedding of music learning in existing social contexts (for example schools), by inventing music games, and competitions, for instance. Applications for research on social bonding and social interaction in public space can explore the types of music that influences the way people behave toward one another in public, for instance when they are listening to music at a concert, when they are shopping or exploring an interactive sounding-art installation.

Applications for research on music learning in an interactive social context or embedding music learning tools in existing social contexts can lie in new tools for: learning how to play a musical instrument or learning how to listen to music. Learning what music is about is often part of early school life. Schoolteachers are, however, not always trained musicians, or do not even have enough musical experience to be able to teach children the basics of it. New educational tools are being developed that will enable teachers to stimulate musical learning and interaction in children. Importantly, this material can contain the knowledge and experience that teachers sometimes do not possess. Collaboration with music schools, conservatories and primary schools, makes it possible to test applications in the situations for which they are being developed. This allows for feedback at many stages of the development of applications, which will maximise the final results.

Conclusion

Music can be the result of social interaction, and it can be the driving force behind social interaction. Both approaches are of great interest to the music research community, and in both cases, the movements of people can provide the insights necessary to understand the relations between social interaction and music. This understanding can help to approach human interaction from a perspective in which music serves as an abstraction of human social capacities, and thus can provide a general method for modelling human social behaviour. Understanding how music facilitates, encourages
and provokes social interaction can also be a stepping-stone to further understand specific mental conditions that have an effect on social interaction. Future challenges lie in developing a model for joint action in music, which will enable us to understand the complex social interaction mechanisms that underlie musical behaviour. This implies addressing issues involved in understanding the complex interplay of different kinds of sensory information in entrainment and action understanding, in developing a model that links entrainment behaviour and interpersonal synchronisation to empathy and disorders in social behaviour and in how music symbolizes mechanisms of muscular bonding and how music functions as a coalition signalling mechanism at the level of measurable movement parameters.
Dit boek is online te koop (klik hier)
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